Performance Upgrade of Siemens SGT-700 Gas Turbine for More Power and Higher Efficiency

SGT-700 previous named GT10C

09-IAGT 301

Anders Hellberg, Product Manager, SGT-700
Siemens Gas Turbines
Complete product portfolio from 5 to 340 MW

Output in MW @ ISO conditions

SGT-700 is derived from SGT-600
SGT-700 Development timeline

- Specification ready, 30 MW
- Design, validation, manufacturing
- Launch to market
- 1st unit started
- 1st unit sold
- New rating 32 MW
- 33 units sold
- Fleet leader 30,000 hours
- Fleet 180,000 hours

Based on SGT-600 design
SGT-600 & SGT-700's spread worldwide

SGT-600/700 has 5.5 million operating hours

As per November 2006
SGT-700 Operating statistics

Average over a life cycle:
98,5% reliability, 97% availability
- including GT & auxiliaries
- not considering lease engine possibility.

Data last quarter
- Reliability 99,7%
- MTBF 1893 hours

This level is backed up with long term measurement on the SGT-600 and SGT-700. SGT-600 has the same basic design and package as SGT-700
SGT-700 Performance

11 stage compressor - pressure ratio 18:1

3rd generation DLE technology
- NO$_x$ on gas 15 ppmv (15% O$_2$)
- NO$_x$ on liq. 42 ppmv (15% O$_2$)

Power turbine 6500 rpm

Mass flow 92 kg/s

Mature rating (shaft)
Power, 32,0 MW
Efficiency 37,4 %
Exhaust temp 528 °C
SGT-700 versus SGT-600

- Improved blade profiles in the compressor
- Improved design of CT blade cooling
- Power turbine on a bigger radius
- Double skin diffuser with some cooling
- One additional compressor stage
- Removable 3rd generation DLE-burners
- Inlet bellmouth adapted to higher air flow
- Same supporting structure
- Same length between bearings
- No change for new rating
Dry Low Emission performance (no change)

3rd generation DLE
Gas fuel operation
• 15 ppm NOx, dry
Liquid fuel operation
• 42 ppm NOx, dry

Film-cooled sheet metal combustor based on SGT-600 design

No change for new rating

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Modifications for SGT-700 mature 32 MW power

Turbine Vane 1
- Film cooling air holes optimized

Turbine Blade 1
- Changed pos of tip cooling holes

Turbine Vane 2
- Cooling air optimization
- Improved sealing

Turbine Blade 2
- No change

Heat Shield 1
- Changed pos of sealing strip

Turbine Vane 4
- Additional sealing strip inner platform
Higher power and efficiency

The compressor turbine efficiency have been improved by:

- Reduced cooling air from areas which has been over cooled
- Improved sealing - reduced leakage

Reduction of cooling air and leakages gives more air to combust and more flow through vane 1

Higher power and efficiency without increase of firing temperature.
SGT-700 Verification

Verification test 1:st unit 2001-2002
- Performance, component life and emissions

Turbine temperature 2003
- Thermo crystal test, detailed information

Fleet leader passes 20 000 hours 2007
- No remarks

Mature rating test 2008
- Stable combustion on all loads and transients
- Power, efficiency and emissions confirmed
- Function of cooling system confirmed
- Component design validated

Thermo crystals
Vane 1

SGT-700 mature in test cell
Package improvements for SGT-600/700

Features

- 24h GG exchange for increased availability
- Commissioning time on site decreased
- Reduced weight and footprint
- Improved API fulfilment
- Solution for roll & pitch
- Same package for SGT-700 and SGT-600
- Several standard options to meet different requirements
SGT-600/700 Package
Main components

- Air inlet
- Ventilation air inlet
- Air inlet plenum
- Ventilation air outlet
- Exhaust
- Gear
- AC generator
- GT driver
- Auxiliary room
SGT-600/700 Package,
Process diagram

- Filter
- Ventilation inlet
- Silencer
- Ventilation outlet
- Gas supply
- Liquid fuel supply
- Driven Equipment
- Lube oil tank
Maintenance plan
Based on operating conditions

- Maintenance at site or local workshop
- Gas Generator exchange at 24 h

EOH = Equivalent Operating Hours
H = Operating hours
Cx = Stress factor
Cf = Fuel factor
EOC = Equivalent operating cycles
Cn = Start and stop factor (1-10)
N = Number of start/stop cycles

EOH = Cx \cdot Cf \cdot H + 5 \cdot EOC
EOC = Cn \cdot N

Stress (Cx) factor versus load

Operation at part load means prolonged time between overhauls
Basic Maintenance Plan

SGT-700

Level D
Level C
Level B
Level A

Operation
Maintenance

Power turbine
Compressor turbine
Reconditioning
Inspection

Eq. Op. Hrs x 1000

10 20 30 40 50 60 70 80 90 100 110 120

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Extended Intervals Maintenance Plan

SGT-700

**Decreased outage by 30%!**

- **Level “C”**: Level B + heat shields
- **Level “B”**: Compressor turbine
- **Level “A”**: Inspection
- **Operation Maintenance**

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- **Eq. Op. Hrs x 1000**
  - 10  20  30  40  50  60  70  80  90  100  110  120
Operation on Nitrogen rich gas

- The test was performed with a standard SGT-700 gas turbine with standard DLE combustion system.
- No modifications were made on the gas turbine
- Minor software changes in control system was made to handle varying fuel composition during test.
Results 20 MW (40% nitrogen)

Drop in Nitrogen flow with stable combustion

Power

Gas flow

NOx emissions

Combustor pulsation
Summary

- New rating, 32 MW
- Higher efficiency, 37.4%
- Robust DLE system
- Single lift package, pre-assembled
- Fuel flexibility
- Improved maintenance
- Excellent fleet experience
- New rating in operation

- More Power
- Less fuel consumption
- Reliable
- Short time at site
- Proven
- Less downtime
- High reliability

--- Efficient, Environmental and Economic Power ---
Thank you for your attention!